



# SOLUTION DESCRIPCION

*Cumucore Private Mobile Network*

## About this document

This document provides an overview of the Cumucore 4G/5G Core platform. It introduces the main features of the platform, as well as provides an explanation as to how Cumucore Network fits into the enterprise IT infrastructure.

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# 1 Private Networks, what are the benefits

## 1.1 Control over network

Private mobile network provides you total control of the network. You can define who can access your network, when they can access, what kind of Quality of Experience they have, what kind of coverage your network has and how much capacity is available. There are no compromises needed because of Internet neutrality or equal service requirements.

Traditional public mobile networks are designed for best effort usage, they provide equal service for different applications, service level is depending on the load of the network. In public mobile network coverage is a compromise between cost and service level. Network dimensioning is done for an average load, compromising customer experience during peak hours. Public mobile network is not a suitable solution for mission critical applications.

Private network service is always designed for a certain customer per location. This means that there are no compromises needed. Network is designed for reliability without a huge cost impact. High reliability is achieved because there is full control of users in the network, low cost is achieved because of modern software technology.

Replacing fixed Ethernet network in the enterprise and factories can be done when using private mobile networks. Private mobile networks are easier to use than fixed networks and can be pre-configured for different situations and for example applications can be prioritized in the case of network failure and other extraordinary situations. Network capacity can be designed to meet the need in any circumstance.

## 1.2 Interference control by frequency coordination

Private Networks use regulated frequency so there are no issues with interference. The network with regulated frequency has a constant network capacity without impact from

random users in the premises. Clean frequency is a base for reliable and predictable service level.

Frequency policies vary between countries, but there are 5G frequencies available around the world. Private networks can work in static frequency allocation or temporary frequency license.

### 1.3 Security on premises installation

Private network can be installed as a standalone network. Standalone networks means that it does not require connection to the Internet. All data can be stored and processed in the premises. Local data management gives uncompromised control of business-critical data and controls operations. Local data operations enable also use cases where applications require millisecond delay.

### 1.4 Volume benefits from standards

Private Networks are 3GPP compliant. Work in 3GPP is going on all the time utilizing the best information network resources in the world. Private networks will have improvements over time and they will meet the future requirements.

Global cooperation means not only state of art technology but also lower cost. There are roughly 10 billion 3GPP standard users in the world. Cost of wireless communication has decreased at the same time when performance has increased. Going forward with 3GPP technology is future proof solution.

5G is not only a new air interface but new network architecture. 5G is based on fully virtualized network functions that means that there is no more need for expensive proprietary hardware and difficult upgrading processes. In 5G it is easy to add new network features and upgrade existing features to meet new requirements.

## 2 Cumucore's private network implementation

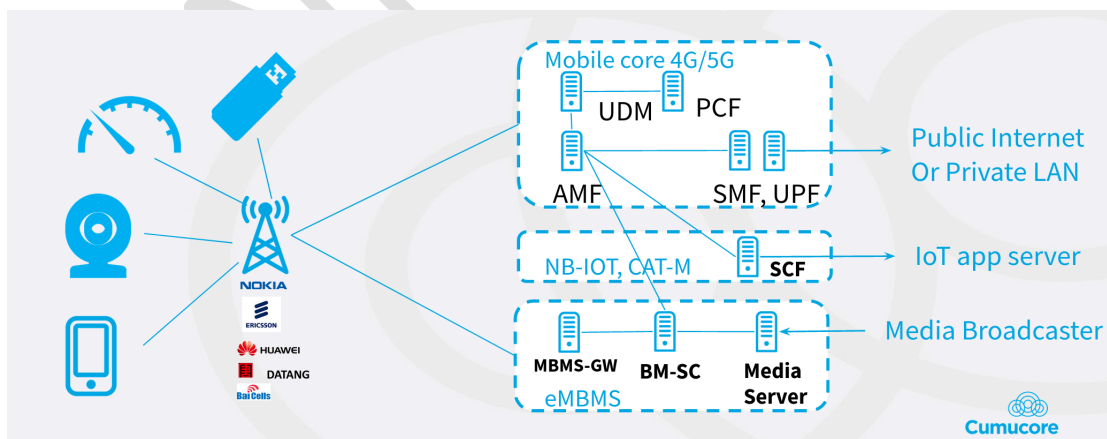
### 2.1 Benefits

Fully virtualized 4G and 5G core that is based on containers. Cumucore's SW architecture scales down very well and makes it feasible to deliver even networks with only one base station. This innovation makes it possible for every business to benefit

from the 5G network development. Running your own mobile network is now possible for everybody!

Cumucore's solution is tailored to meet different vertical industry needs. Cumucore can deliver an end-to-end solution using commercially available end devices and eNB/gNB from Nokia. Cumucore is 3GPP compliant so any eNB/gNB vendor will work with. Cumucore supports base stations from femtos to macros.

Figure 1 Network Architecture



### 2.2 Affordable

Cumucore 4G/5G core runs on virtualized environment. The virtualized environment can be installed on any commercial Linux computer platform. This is not only very

cost efficient but also very scalable. Cumucore core can be scaled up and down based on the current need of network resources. The same computer platform can also host resources

for local applications. This reduces application latency to minimum and also can help to reduce transmission needed to the Cloud.

### 2.3 Easy to use

Traditionally mobile networks have been difficult to use with several network elements that require specially trained personnel. Cumucore has been able to develop a simple user interface that is controlling the whole network. The Cumucore network has all the

functions that 3GPP has specified, we have developed a “skin” on top of them to deliver interfaces that you can use with regular IT skills.

Using Cumucore does not require any special mobile networking skills. Needed base stations and SIM/eSIM cards will be delivered preconfigured for immediate activation. You can install Cumucore 4G/5G core on your local environment and configure the network by yourself. Network can run as a standalone network, as a part of fixed LAN infrastructure or connected to the Internet as a regular mobile network. Network can run on a regular 19" server but in the smallest configuration it can run on a very small box that can be carried around with you wherever you might need a powerful mobile network.

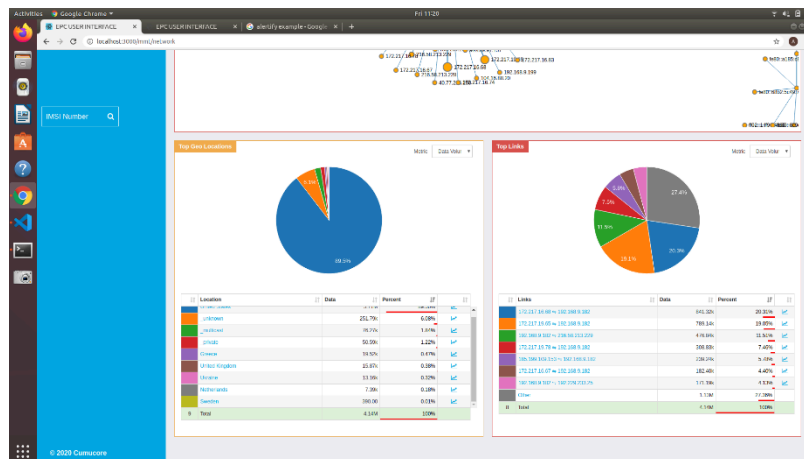
### 2.4 Innovative Service Level enforcement

In mobile networks user experience is defined by the number of simultaneous users and used modulation. Used modulation lowers in the function of distance the user device has from the base station and RF interference. To provide a reliable and stable communication, it is mandatory to define needed quality of experience per application



and fine tune network parameters per application dynamically to meet the needed application SLA. This is what we call dynamic Quality of Service management.

Figure . Network KPI



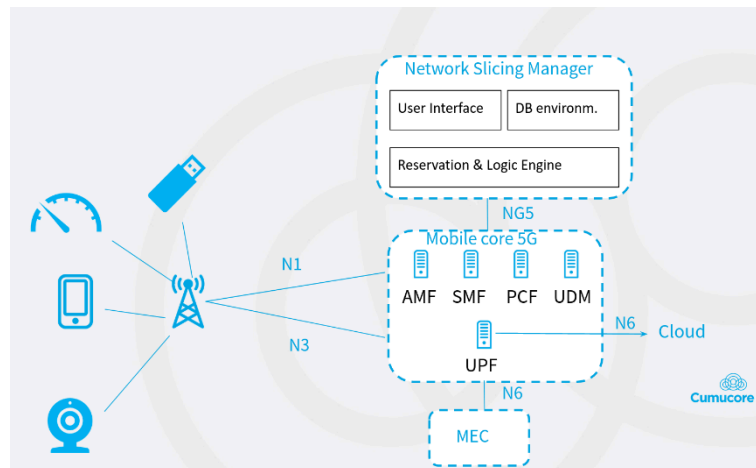
## 2.5 Network slicing

Network Slicing means that one physical network can deliver several logical networks that has no dependency between themselves. If one Network Slice is capacity overloaded it has no impact on the other slices.

In private networks slicing can be used to provide different slices per application type eg. video and voice. slices can be organized per organization eg. HR and production or per type of devices e.g. machine type communications (MTC) or personnel communications.

Network slices can have different service characteristics, downlink capacity, uplink capacity, delay and jitter.

Figure . Network Slicing



## 2.6 Multi-tenant capability

Cumucore network slices can be shared by different organizations. One physical network can serve many companies, families or individuals. Different slices can be equal in sizes or they may differ. Network slicing separates slices from each other. Slicing can be made static or dynamic. Static slicing means fixed boundaries between slices and dynamic slicing means that slice resources can be shared between different slices if/when needed. Dynamic slice resource management enables static multiplexing gain in some use cases.

## 2.7 Automatic network slice management per traffic content

In the case network slicing is done per application, Cumucore DPI functionality can recognize the traffic and provide the planned performance to the data flow. This is possible because there is no Internet Neutrality requirement in private networks. This

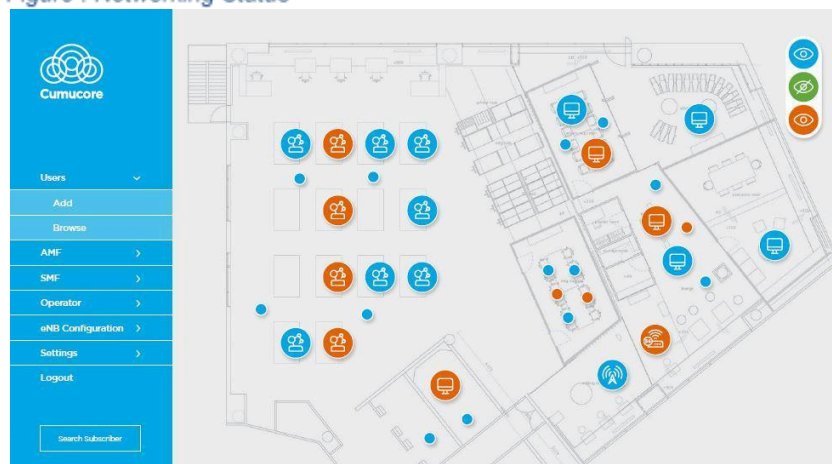
feature can be used for example to improve business critical applications performance in office buildings.

### 3 Mobile Network features

- **Network planning**

Cumucore network planning is based on building lay-out industry floor plant drawings. Cumucore management tools provide a clear and easy to use view on user equipment level status and location.

Figure . Networking Status



- **Redundancy**

Building redundancy is very easy in 3GPP networks. Redundancy of radio networks is built into mobile networks. If it happens that one eNB/gNB has a failure all the traffic is moved to another eNB/gNB in milliseconds. The recovery from failure situation can be designed by network dimensioning or by application prioritization. Because of

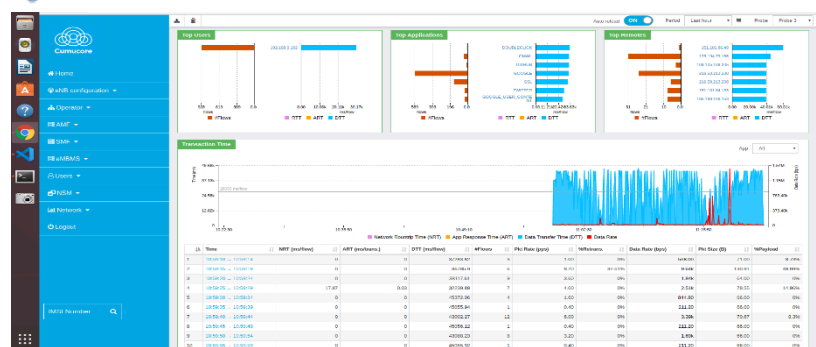
virtualized software architecture Cumucore Network Core

(NC) can have redundant functions inside one server or the servers can be duplicated to provide geographical redundancy.

- **Cumucore User Interface**

From Cumucore network management tool you can see network overall status, user level status and data flow status. Network can provide uplink/downlink capacity (Mbps), delay (ms), jitter (ms) and packet error rate (%)

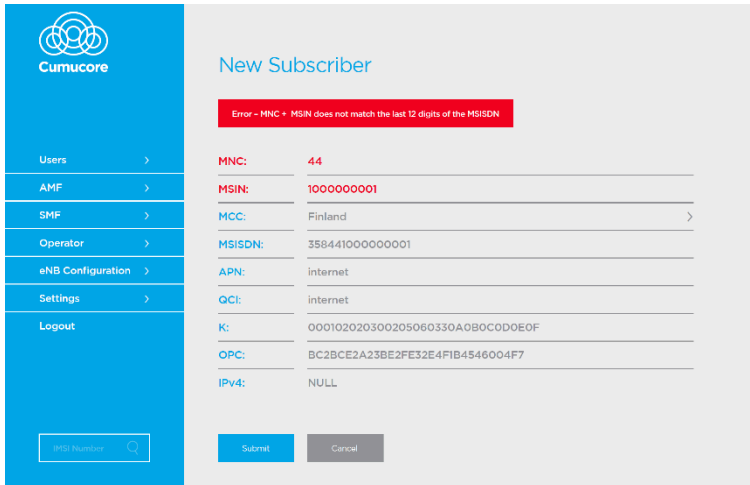
Figure . Network Performance



- **User management**

Cumucore will deliver needed SIM/eSIM cards to the network. Cumucore network manager can add users, edit user privileges and remove users. In Cumucore NC you can define different quality of service levels, priorities, pre-emption rules.

Figure . User Management



**New Subscriber**

Error - MNC + MSIN does not match the last 12 digits of the MSISDN

MNC: 44

MSIN: 1000000001

MCC: Finland

MSISDN: 35844100000001

APN: internet

QCI: internet

K: 000102020300205060330A0B0C0D0E0F

OPC: BC2BCE2A23BE2FE32E4F1B4546004F7

IPv4: NULL

Submit Cancel

- **Mobility and roaming**

Cumucore network supports handovers between base stations. Roaming between networks is supported. Cumucore NC is 3GPP rel 16. compatible supporting following radio access networks

- 4G / LTE
- 5G - NSA
- 5G SA
- WiFi

- **Capacity**

- Number of data flows 100 000
- Number of users 10 000

- Number of eNB/gNB 10
- Over all UPF throughput 40 Gbps

- **Installation**

Cumucore can be installed on any servers running Linux. This means that depending on the selected server Cumucore NC can be installed anywhere. Base stations can be small or large, indoor or outdoor versions.

Cumucore NC can also be installed on cloud. At the moment installation on AWS is supported.

*Figure . Example of installation*



### 3.1 5GLAN

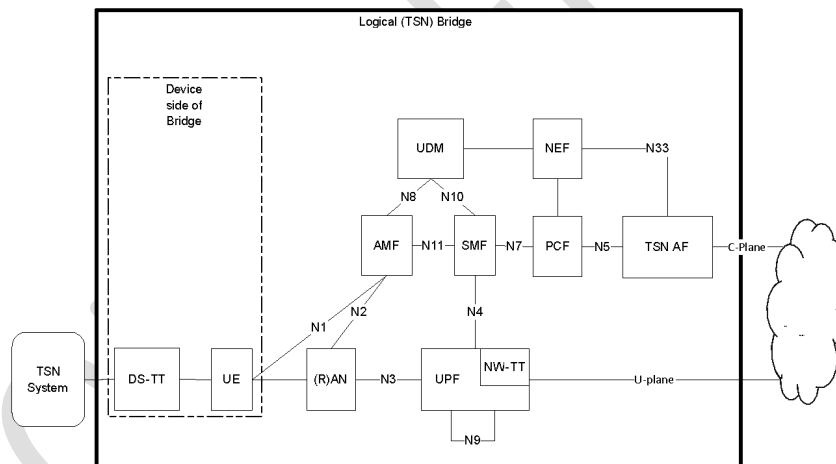
Cumucore NC supports a unique feature called 5GLAN. This feature makes it possible to connect a private mobile network to be part of corporate regular IT

infrastructure. Devices served by private 5G networks can be discovered from outside LAN as a regular Ethernet device.

### 3.2 Time Sensitive Network

Cumucore network can provide TSN synchronization for the devices it serves as defined by IEEE802. TSN is a very practical way to deliver accurate synchronization to devices in indoor locations where GPS synchronization can not be used.

Figure . TSN Architecture



### 3.3 Network Slicing Manager

Delivering several virtual networks from one physical network is enabled by Network Slicing Manager. Network Slicing Manager can define slice sizes, different quality of service per slice, traffic rules per slice including prioritization and pre-emption rules. Through Network Slicing Manager you can manage access right to the network slices in the multitenant use case.

### 3.4 Mission Critical Push To Talk

Cumucore NC supports push to talk functionality (MCPTT). Push to talk is a feature that can be used in group communication cases that is required in private networks for high priority personal communications.

### 3.5 IoT gateway

Manage IoT devices with extended battery life and local data processing capability. IoT gateway provides an opportunity to do local break-out for IoT data in the case of centralized core.

### 3.6 Media broadcast server

Mobile networks can also be used in multicast mode. Media broadcast server provides a capability to broadcast video or audio streams over the network area.

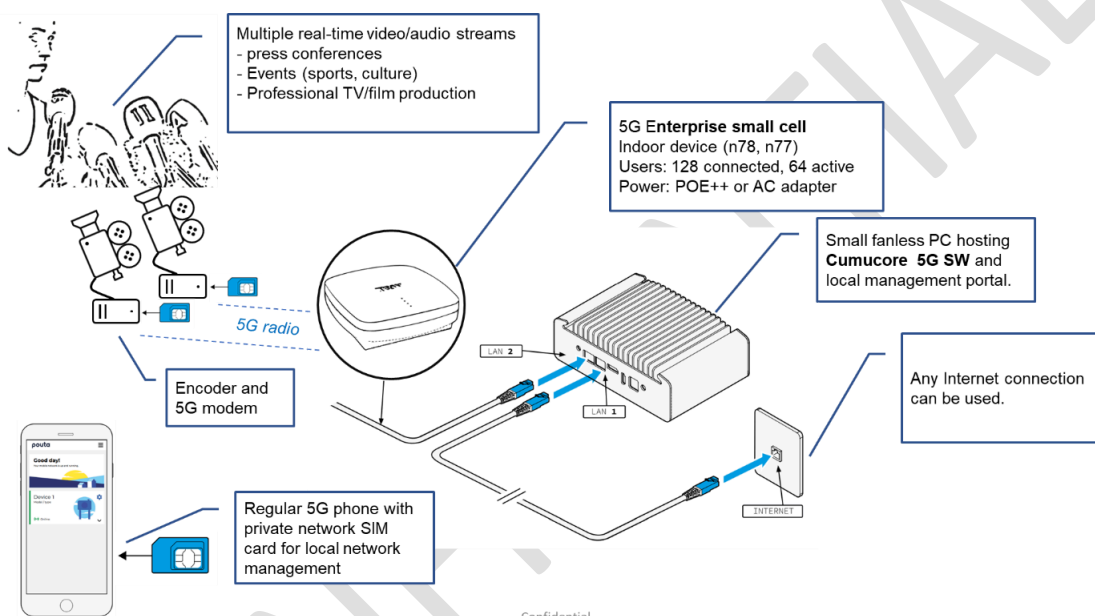
## 4 Use case examples

### 4.1 Media broadcast server

Media production requires reliable and stable connectivity to connect audio devices to locations where a director is mixing different information sources into one media stream. Stream from the camera requires a high uplink bit stream. 5G radio technology provides an opportunity to replace physical cables on the production site to reduce set-up time. Robocameras can also be set up faster because there is no need to establish proprietary radio links. When cameras are all connected to a fiber network, it makes it possible to locate the director remotely. Remote production is a significant cost reduction opportunity and also reduces the need to move people around production sites.



Figure . Multicamera production Use Case



## 4.2 Industry 4.0 - replacing ethernet cables

Installing Ethernet cables in the factories and offices is costly and makes it difficult to change office or production line configurations. Replacing Ethernet cables by radio technology requires clean frequencies, 5GLAN capability and in some cases also TSN functionality. When 5G based infrastructure is in place the same network can be used to control machines, autonomous vehicles and provide voice communication including group communication etc. One 5G network can replace several different communication solutions not only bringing in cost savings but also significantly improved integration capabilities between IT systems.

Private mobile networks can be managed accurately per application and different departments can have their own virtual networks. Virtual network settings can be changed dynamically to meet the needs of the current situation.

### 4.3 Enhanced video cameras

Video cameras can be used to recognize humans but also be part of process controls. Image recognition requires a lot of computer resources but it also requires a very low latency communication network and very high uplink capacity. Private mobile networks will give full flexibility to install video cameras in the best possible location from a process control point of view. Video cameras can be mobile and be installed temporarily in the place that requires surveillance.

To use video cameras to recognize something and to use that information in real time decision making, requires very low latency, high uplink bit rates and very high security level. These are natural features of private mobile networks.

## 5 Cumucore computing requirement

Minimum hardware requirements for running Cumucore 4G/5G cores are:

*Table 1. Hardware Requirement*

Resource	5G (NC)
RAM DDR	8 GB
Hard drive	10 GB min, 100 GB recommended
Processor	4 core 64 bits

NIC	2 x 10Gbs Tested with XYZ
OS	Ubuntu 2.XZ

The hardware system that runs the 4/5GC requires at least two interfaces.

- The first interface (e.g. enp2s0) is used to connect the 4G/5GC to the Radio Access Network (RAN).
- The second interface (e.g., enp3s0) connects the 4/5GC with Packet Data Network (PDN) that can be private or public Internet based network.
  - The enp3s0 interface can have an IP address from the DHCP server or the IP address can be assigned manually as well (Depending on whether the user has a DHCP connection attached or not during installation).
  - The default route should be through this interface. Loopback addresses are also in use by the 4/5GC. NAT (for outgoing traffic on enp3s0 interface) and IP forwarding is enabled.
- The 4/5GC might have another interface (e.g., enp1s0) for management purposes (e.g. ssh connectivity).

Cumucore EPC can be run on Virtual Machines.